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50X1-HUM

COUNTRY USSR

REPORT

SUBJECT "Main Branches in the Development of Protozoology in the Pre-Revolutionary Russia and the Soviet Union"

DATE DISTR. 6 Dec 61

NO. PAGES 1 50X1-HUM

DATE OF INFO.

PLACE & DATE ACQ

THIS IS UNEVALUATED INFORMATION

document entitled "Main Branches in the Development of Protozoology in the Pre-Revolutionary Russia and the Soviet Union", by Professor G Poljansky, Institute of Cytology, Academy of Sciences of the USSR and the University of Leningrad. 50X1-HUM

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Institute of Cytology, Academy of Sciences of the USSR
and the University of Leningrad

Prof. G. Poljansky

MAIN BRANCHES IN THE DEVELOPMENT OF PROTOZOOLOGY IN THE PREREVOLUTIONARY RUSSIA AND THE SOVIET UNION

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Main Branches [illegible] Protozoology
in the Prerevol[illegible] Soviet Union

Pr[illegible]
Institute of Cytology, Academy of Sciences of the USSR
and the University of Leningrad

I -INTRODUCTION

A study of Protozoa in the prerevolutionary Russia and the Soviet Union, as well as in other countries, has always been a subject of great interest for many investigators. From the very beginning the development of protistology appeared to be closely connected with numerous problems of general biology. It can be explained by the peculiar nature of protists themselves, most of which are the organisms on the cellular level of organization. That is why the questions of studying Protozoa as zoological objects are closely interwoven with the problems of general cytology, cell physiology, reproduction physiology etc.

A special interest to protozoology also may be explained by its great practical significance. Its close connection with medicine and veterinary medicine is indisputable.

In the review given below we may dwell only on the main points in the development of protozoology in the prerevolutionary time and the Soviet period for the general amount of protozoological works in our country attains such a vast number that a detailed account would require a book. Here we shall not touch specially the questions of medical and veterinary protozoology.

The first original studies on protozoa in Russia began in the 70th of the last century. Among the protozoologists of that period the name of I. CIENKOWSKY is to be mentioned first. In

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1873 he investigated the [illegible] Noctiluca and published a series of articles on [illegible] structure and biology of Euglena etc.

A number of works on systematics and morphology of Infusoria were published in the 70th and the 80th by S. MERESHKOWSKY, S. PEREJASLAWZEWA and J. ANDRUSSOWA.

At the same period W. DANILEWSKY made his well-known studies on parasitic Protozoa of the blood. He also published his investigations on trypanosomes and life cycles of some Haemospodidia of birds and reptiles, these works being an important stage in the study of malaria parasites.

By the end of the 19th and at the beginning of the 20th centuries in Russia we can observe a further development of protozoological investigations. At this time W. SHEWIAKOFF published a series of works among which the monograph "Organization and Systematics of Infusoria Aspirotricha" (1896) and some other studies on ciliates and gregarines are to be specially mentioned. Shewiakoff who was for several years head of the Invertebrate Zoology Department of the St. Petersburg University, played a very progressive role in the development of protozoology in Russia. Among his collaborators we should name such prominent protozoologists as S. A[illegible] and [illegible].

In 1906 Awerinzew wrote a monograph "[illegible] of Fresh Waters" in which he gave a detailed analysis of the morphology and systematics of the fresh water [illegible]. Since 1[illegible] to 1910 V. Dogiel published a number of works devoted to the peculiar parasitic Dinoflagellata which he joined into one group, Catenata. At this time V. ELPATJEWSKY [illegible] and [illegible]WARSHEWSKY (1912)

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published their investigations on the nucleus and the reproduction of certain fresh water Rhizopods and S.METALNIKOW made his well known studies on the physiology of Infusoria digestion. He managed to discover the change of acid and alkaline phases during the intracellular digestion, the relation of nutrition intensity and cyclose rate to the kind of food and the environmental conditions etc.

At this time JAN DEMBOWSKY - a famous Polish protozoologist - began his scientific investigations of physiology of Protozoa (mainly, taxis and tropisms) at the St. Petersburg University. Later on, in Poland, he became the head of the Polish School of physiologists of Protozoa.

To this period belong the first publications of V.LAKHMOW on parasitic Protozoa of domestic animals (Coccidia, Piroplasmidae, Trypanosoma etc.). His scientific career lasted for more than fourty years.

Among the protozoological investigations carried out at the beginning of the 20 century the works of N.K.KOLZOFF and his collaborators (ROSKIN and others) devoted to the morphology of Infusoria, their skeletal and contractile apparatus should be mentioned.

After the Great October Revolution the study in the field of protozoology took a vaster scope which was in close connection with general progress of science in the Soviet Union.

New research institutions and higher schools arose in different parts of the country. A great many people began working in the field of zoology and protozoology, in particular. New protozoological schools appeared in Leningrad (V.DOGIEL) and

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and in Moscow (N.KOLZOFF):, good results were achieved by the protozoologists of V. YAKIMOFF's school in the field of veterinary protozoology. Dozens of young investigators took interest in the problems of protozoology. There appeared a great number of publications. To give a brief account of the protozoological works for the period since 1920 to 1960, we shall group the most important of them, according to the principal branches of investigations.

II Systematics, faunistics and ecology of Protozoa

Investigations of Soviet scientists in the field of faunistics and ecology embrace many groups of Protozoa, but not all of these groups have been studied in equal degree. Thus, free-living Infusoria appear to be known the least, while the greatest attention was always paid to some groups of parasitic Protozoa.

Among the works on Sarcodina W.SCHEWIAKOFF's monograph on Radiolaria Acantharia (1926) must be mentioned first of all. In this fundamental study carried out on the Mediterranian material, the author thoroughly analysed the systematics, morphology as well as reproduction and life-cycles of Acantharia.

Radiolaries from different seas of the Soviet Union were studied by T. BERNSTEIN (1928-1931), V. DOGIEL and V. RESCHETNIJAK (1950-1955, Far East seas). DOGIEL and RESCHETNIJAK made a close study of a vertical distribution of Radiolaria in the Sea of Okhotsk.

Since the 30th of the 20th century T. STSCHEDRINA has been studying Foraminifera of the Soviet seas, mainly, of the Northern and Far Eastern seas. The author paid a great attention to the relation between the distribution of Foraminifera and hydrological and geographical factors.

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Of great interest is the discovery of A. BRODSKY (1928, 1929) in the wells of the Kara-kum desert, who found a fauna of manychambered living Foramanifera which the author considered to be a relict marine fauna.

Some observations on the faunistics of the fresh water Testacea from the North of the European region of the USSR were published by G. GASSOVSKY in 1936.

A lot of investigations made by the Soviet scientists (P.SCHIRSCHOW, 1937; P.USSATSCHEW, 1947 and KISSELEW, 1950) dealt with free-living Mastigophora regarded as a plankton compound of fresh and sea water reservoirs.

Of great interest is the monograph of the free-living Infusoria from the Baikal Lake published in 1933 by N.GAJEWSKAJA. Alongside with the faunistic and systematical material, this work contains a great many observations of the Infusoria spreading in relation to hydrological factors.

A number of investigations on soil Protozoa has been published in our country since the thirties. In 1930 L. LOZINA-LOZINSKY worked out a special method allowing to study the swiftness of Protozoa distribution in soil. BRODSKY who had made his studies on the Central Asia soils maintained the conception (1935,1945) about the existence of a specific complex of Protozoa ("Pedabionts") in the soil. One of the most convincing investigations of the Central Asia soils, carried out during the last years, is W. NICOLJUK's work (1948, 1956). He showed the availability of active stages of Protozoa in the soils (under conditions of the moisture required) which he considered to take an active part in the soil biodynamics.

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Among the investigations treating the systematical and faunistic problems of parasitic Protozoa, the articles of G. EPSTEIN on the parasitic amoebas must be named first. A number of works on systematics and ecology of intestine Protozoa (chiefly, the intestine amoebas) were published by V. GNEZDILOFF (1934-1951), A. AWAKJAN (1936,1949), A. PHILIPTSHENKO (1933, 1935), Sh. MATEVOSJAN (1932-1951), D.S.NIDZE (1955), E. CHEISSIN (1937) and some others.

Thank to these numerous investigations, the Protozoa of human intestine on the territory of the USSR has been thoroughly studied.

To the classification, faunistics and ecology of some groups pf parasitic Infusoria has been always paid a good deal of attention. First of all, a great number of DOGIEL's works should be mentioned. DOGIEL wrote a number of articles concerning Infusoria Entodiniomorpha from the ruminant's rumen, most interesting of them being the monograph on Ophryoscolecidae (1927) and the study of the phylogeny of Infusoria from the ruminant stomach in the light of paeonthological and parasitological data (1947).

Another large investigation of the ciliates from the hoofed animal intestine is the monograph by A.STRELKOV "Parasitic Ciliates from the Intestine of the Perissodactyle Fam. Equidae"(1939). There are many ecological data as well as a vast morphological systematical and faunistic material in the bool.

Several investigations of Russian protozoologists were specially dedicated to the problems of the Ophryoscolecidae ecology. Dogiel studied the questions concerning the choice of food and the nutrition of these Protozoa. G. POLJANSKY, A.STRELKOV and M. ISSAKOVA-KEO (1933- 1935) investigated the ways by means of

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which Infusoria manage to infect the ruminant, and also the influence of Infusoria on the growth and development of the host.

In 1930 E. CHEISSIN published his vast study on systematics and morphology of Infusoria Astomata dwelling in the invertebrates from the Baikal Lake, and in 1931 - another investigation of Infusoria Boveridae and Ancystridae from the Baikal molluscs. G. POLJANSKY, M. GOLIKOVA and A. STRELKOV in the years 1951, 1957 and 1959 published a number of papers on systematics and ecology of Infusoria from the sea urchin and some other marine invertebrates.

A long series of publications (about several hundreds) on systematics of various groups of parasitic Protozoa had been written by V.I. YAKIMOW and his numerous pupils (E. RASSTEGAJEWA, N. KOL-YAKIMOVA, V.GUSSEW, J. GALUSO, W. BELAVINE etc.). These investigations had begun before the Revolution and did not cease after YAKIMOW's death. The authors named above, dealt mostly with trypanosomes, Coccidia, Piroplasmidae. Some of these works are of veterinary nature (prophylaxis as well as treatment of diseases induced by protozoans), but most of them are devoted to the problems of systematics. Professor Yakimow and his pupils described dozens of new species of parasitic Protozoa, Coccidia in particular. A considerable part of YAKIMOW's works and those of his pupils written before 1930 found its reflection in his large book "Domestic Animal Diseases Induced by Protozoa". (Veterinary Parasitology, 1931).

In 1931 G. EPSTEIN published a vast summary "Patogenic Protozoa, Spirochetes and Fungi. Principles of General and Medical Protistology".

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N. ORLOV with his collaborators studied the biology of Coccidia. The summary of their numerous publications appeared in 1956 (N. ORLOV "Coccidiosis of Domestic Animals").

A number of A. TZELISCHEV's works deal with the questions of systematics and spreading of Theilerias on the territory of the USSR,

The problems of systematics and spreading of Myxosporidia are treated in many investigations of fish parasitology of the Soviet Union. On the base of these works in 1932 Dogiel worked out a summary and determinant of the fresh water Myxosporidia in the USSR. A series of articles specially devoted to the fauna of Myxosporidia in the Soviet Union was written by G.PETRUSHEVSKY in 1932 (The White Sea), in 1953 by S.SHULMAN (The White Sea) and in 1948 by V. DOGIEL (The Far East seas).

Soviet protozoologists published some works dedicated to the questions of evolution, species formation and the system of Protozoa in the year 1929 in his article "Polymerization as a Principle of Progressive Development of Protozoa" V.DOGIEL gave an analysis pf morphological regulatities in the evolution of Protozoa. The author came to the conclusion that polymerization (multiplication of the number of homologous organelles) was one of the main branches of progressive evolution of Protozoa.

Many other protozoologists developed this idea relative to phylogenesis of some separate groups of Protozoa.

In 1957 G. POLJANSKY devoted a special work to the problems of interspecies differentiation and the structure of Protozoa species. A detailed critical analysis of the proposed system of Sprozoa was given by E. CHEISSIN in a special article of 1956.

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In 1959 S. SHULMAN offered a new system of Myxosporidia, chiefly, based on the spore structure, the main lines of phylogenesis of the order being taken into consideration. This system allows to take into account the principal ways of phylogenesis within the limits of one order.

III Morphology and cytology of Protozoa

Among numverous publications on morphology and cytology of Protozoa, the investigations of skeletal and fibrillar apparatus should be pointed out first. The investigations are based on the conception of the Russian cytologist N. KOLZOFF, according to which "each cell, if it is not spherical, has a rigid skeleton which gives some definite outline to the liquid protoplasm". KOLZOFF himself applied this principle to some of his studies on the spermium of different animals and on the stalks of Infusoria Peritricha. The Soviet scientists unsed KOLZOFF's idea in their protozoological investigations, soke skeletal structures of euplasmatic and alloplasmatic nature being described for various objects. In 1925 G. ROSKIN stated skeletal character of the fibrils in gregarines. Since 1927 to 1931 L. PESHKOWSKAJA published a series of articles where she described fibrillar skeletal structures in some Infusoria; most detailed description has been given specially for Trichodina. In 1941 LEVINSON investigated skeletal elements in Boveria. In 1939 STRELKOV gave a detailed description of fibrillar structures in Infusoria Entodiniomorpha from the horse intestine and, thus, stated " a comparative anatomy" of these structures for a large number of species. The works of Russian investigators on fibrillar structures of Infusoria did not confirm the conception of KOFOID, SHARP, TAYLOR, YOKOM and

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and others about the existence of neuromotor apparatus in Infusoria. Fibrillar structures, according to KOLZOFF's theory, are regarded by the RUSSIAN authors as supporting skeletal structures. The alloplasmatic skeleton of Infusoria Entodiniomorpha was thoroughly studied by V. DOFIEL and A. STRELKOV (1939). They managed to show that the skeleton of these Protozoa consisted of some substance similar to cellulose. A complex morphology of skeletal plates allowed them to work out a comparative anatomy of the skeleton which was analysed in detail in STRELKOV's monography.

A great number of investigations carried out by the Russian protistologists are devoted to studyung of organoids and inclusions of the Protozoa cytoplasm; such as the publications of A. RUMJANZEV on cytology of different species of Rhizopoda Testacea (1922-1925), B. WERIEL's on mitochondria and cytoplasmic inclusions of Amoeba hydroxena(1925), D. ZASUCHIN's work on cytology of Entamoeba blattae (1929), K. SUKHANOVA 's investigation on chondriosoms and reserve inclusions in Opalina (1953, 1959); G. STEIN's study on cytology of gregarine (1960) etc.

Of great interest are the studies of D. NASSONOV on the contractile vacuole of Protozoa (1924, 1925). Having applied the osmic acid method he managed to discover constant existence of vacuolar walls. This was contrary to the conception of the temporary character of the contractile vacuole; so that the contractile vacuole;appeared to be a constant organelle of Protozoa.

Since the fourties in the Soviet protistological and cytological literature we can observe an increasing interest to the study of nucleic acids - RNA (ribonucleic acid) as well as DNA

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(desoxiribonucleic [illegible] in the development of cyto[illegible] ical of the second quarter of [illegible] cytochemical and op[illegible] others) provided with [illegible] cytology of Protozoa. [illegible] RNA and DNA distribution [illegible] (E. GROMOVA, 1,41, [illegible] 1947 etc.). Later on, [illegible] component of each cytophysiological investigation, especially, when it concerned life cycles of Protozoa. The latter topic will be considered in the following part of our article.

IV Reproduction and Life Cycles of Protozoa

Problems of reproduction and life cycles of Protozoa always attracted attention of Soviet protistologists. Alongside with morphological investigations, many specialists take great interest in physiological and ecological approach to the subject. During the recent years a cytochemical analysis of life cycles has made big stride.

In 1925 DOGIEL published a very interesting work on the conjugation of Infusoria Entodiniomorphe. In this forms he has found out a specific "progamic" division leading to the formation of preconjugant generation. [illegible] of conjugation of Entodiniomorphs with sexual processes of Metazoe is of great interest, a male pronucleus assumes the shape of spermatozoid and through the cytopharynx it penetrates into the conjugating partner.

POLJANSKY in 1934 studied the conjugation of Bursaria trunca-

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tella. Applying cytochemical methods, he investigated the way of development (ontogenesis) of the macronucleus and revealed a peculiar process of chromosomal longitudinal splitting, which, latter on, GRELL regarded as an endomitosis leading to polyploidization. The morphology of conjugation was investigated in some other species: in Lionotus (I. MESJATSEV, 1924), in Cryptochilidium (L. DAIN, 1930), in Dogielella (G. POLJANSKY, 1926), in Zoothamnium (A. FURSSENKO, 1926) etc.

Of the morphological and cytological investigations of reproduction processes in Infusoria most interesting is a series of articles on lower ciliated Infusoria Trachelocerca, Geleia, Loxodes published in 1957, 1958, 1959 and 1960 by J. RAIKOV. The auther managed to show that the nuclear apparatus in these forms differs significantly from the nuclear apparatus of other ciliated Infusoria. The macronuclei are diploid and not capable of division; they increase in number at the expense of the macronuclei every time during the division of Infusoria. A series of primitive peculiarities are characteristic of the nuclear processes during the conjugation of Trachelocerca. Basing himself on the study of the nuclear apparatus in lower Holotricha, RAIKOV has worked out a new theory concerning the origin of the nuclear dimorphism in Infusoria. The division processes and the conjugation of Infusoria have been studied by the Soviet protistologists from the physiological point of view. W. TROFIMOVITCH in 1936, G. GORBUNOVA in 1937, T.MARKOVA in 1941 and some other protozoologists investigated physiological changes in Paramecium between two divisions, i.e., "age" changes. W. BARBARINE and L. SOLOVJEWA in 1947 and BARBARINE in 1958 studied changes of oxidizing processes in the

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course of conjugation in Bursaria truncatella. Direct measurements of respiratory energy showed that the conjugation resulted in the increase of metabolism level. In a series of studies the processes of encystment in Ciliata were subjected to investigation from the morphological as well as physiological points of view. S. ILOVAISKY in 1926 and N. POMRJASNINSKAJA in 1940 investigated of some species of Hypotricha. Special attention was given to the formation of cyst membrane, nuclear processes, changes occuring in the cytoplasm.

Several investigations were devoted to the study of the cycles of Infusoria in natural reservoirs. In 1929 A. FURSSENKO (1929) in his most interesting work analysed thoroughly an annual life cycle and development of Zoothamnium arbuscula.

A detailed cyto-physiological study on the life cycle in Opalina ranarum was made by K.SUKHANOVA in 1953. O. BAUER in 1955 studied the life cycle in Ichthyophthirius multifiliis. A great deal of attention has been contributed to the factors of the environmental conditions, necessary for different stages of the life cycle.

Among the studies on the life cycle of Sporozoa the most interesting i s a series of E. CHEISSIN's publications (1947-1959) on rabbit Coccidia. He studied in detail the endogenous and exogenous parts of the cycle and stated that the agamic endogenous part of the cycle is strictly limited to some definite number of schizont generations. In his recent studies published in the years 1960 and 1958 CHEISSIN drew the picture of cytochemical changed during the life cycle of Coccidia Eimeria. He studied the dynamics of polysaccharides, mucopolysaccharides, lipides,

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nucleic substances etc., These investigations are very precious for they afford cytophysiological characteristics of the complex life cycle of Sporozoa.

From the same cytochemical point of view G. STEIN studied the life cycles of gregarines.

During the recent years in our country Piroplasmidae have been thoroughly investigated (A. MARKOV, I.ABRAMOV and others). The cycles of this mysterious (as to their position in the system) bloodparasites were differently considered by different authors. The Soviet investigators who studies the life cycles of Babesielle bovis and Piroplasma bigemium in tick-carriers (POLJANSKY and CHEISSIN, 1954; CHEISSIN and MURATOV, 1959) deny sexual process in Piroplasmidae. They believe that these organisms do not belong to Sprosoa and are to be referred to Sarcodina.

IV Physiological studies on Protozoa

The investigation of the life cycles in Protozoa, to a considerable extent, is byond the limits of morphology and in some degree concerns the problems of physiology. But alongside with the works of such kind, the Soviet protozoologists studied pure physiological topics.

Studies on the processes of nutrition and intracellular digestion were initiated by the work of S. METALNIKOW. Later on, in the period from 1923 to 1931, L. LOZINA-LOZINSKY worked on the same problem. He published a series of articles in which he showed that a process of the "take up" and choice of food in Paramecium is a very complex phenomenon similar to chemotaxis. The Infusoria most willingly swallow those substances which in-

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duce in them a positive Chemotaxic reaction. The factors, necessary for phagocytosis, are very variant and depend not only on the environmental conditions but also on the physiological state of Infusoria.

The effect of various salts on the process and rate of phagocytosis in Infusoria was studies by DOGIEL and his collaborators in 1928 (DOGIEL, ISSAKOVA-KEO, STRELKOV). Different salts influenc the rate of phagocytosis like the process of defecation. In 1937 CHEISSIN on Entamoeba histolytica cultures showed a great influenc of pH on the process of erythrocytes phagocytosis. In a series of works on Paramecium caudatum Barbarine studied the effect of various diets and starvation on the storing of glycogene and fat inclusions in the cytoplasm.

A number of investigations were dedicated to the oxidising processes in Protozoa. In the laboratory of G.ROSKIN, by means of cytochemical methods, entym base of oxidizing processes has been investogated (G.ROSKIN and L.LEVONSON, 1926; G. ROSKIN and W. SEMJENOV, 1933, etc.) BARBARINE and SOLOWJEWA devoted their investigations to a direct study of respiration of Infusoria (1941-1947). As an object a large Infusorium Bursaria truncatella has been used. The authors discovered changes in respiratory intensity on different stages of the life-cycle and showed two mechanisms, one of which was eliminated by KCN, while the second appaered to be independent of the specific action of cyanide.

The phenomena of irritability and motoring reactions of Infusoria in 1957 were studied by H. KOSHTOJANZ and his collaborators (H. KOSHTOJANZ and N. KOKINA, 1957). They indicated a great influence of the acetylcholin-cholinesterase system on the chemic-

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al dynamics of the cilia movements. Besides this, they investigated the summation phenomena of irritation.

During the last years some Soviet protozoologists have studied the phenomena of adaptation of protozoa to different factors of the environment. On free-living and some parasitic Infusoria and Opalinidae (M.OLIFAN, 1935, G. POLJANSKY and A. ORLOVA, 1948; G. POLJANSKY,1957-1958; K. SUKHANOVA, 1959 etc.) changes in thermostability in respect of adaptation to various temperature conditions of the environment have been studied. An unusually wide range of individual adaptation of protozoa to temperature factors has been discovered. Besides, adaptation of free-living Infusoria to changes in the salt contents of the medium have been shown (A. ORLOVA, 1941, 1947; L.SERAVIN, 1957, 1958, 1959 etc.). The authors stated a wide range of adaptation possibilities and investigated the conditions under which long-lasting modifications occur (ORLOVA). SERAVIN who studied various functions in Infusoria during the process of adaptation (surviving, phagocytosis, activity of contractile vacuole etc.) found out the phasic ways (triphasic way, as a rule) of Adaptation changes as a general time regularity of the adaptation process.

A number of investigators tudied the influence of different kind of ionizing radiation (N.KOVALJEVA, 1948; L.LOZINA-LOZINSKY, 1951, 1958; E.ZINOVJEVA, 1956; G. OGINSKAYA, 1959; L. LOZINA-LOZINSKY, 1958). The greatest attention was paid to the physiological side of the process of irradiation injuries development.

VI. Genetics of Protozoa and problems of species formation

Studies of the Soviet protozoologists in the field of genetics of Protozoa has been devoted, mainly, to the problems of varia-

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bility and its dependence on the environmental factors. The elaboration of all these questions, however, has been carried out in close connection with the study of adaptations, the nature of interspecies polymorphosm and the mechanism of natural selection and species formation. POLJANSKY and STRELKOV in 1938 and S. KIEL in 1940 studied the variability and nature of interspecies polymorhpism in Infusoria Ohpryoscolecidae parasitizing in the rumen of rimunants. The investigations required a special technique of obtaining clones of some species of Orphyoscolecidae in a sterile animal (in respect to Infusoria). This work made it possible to reveal a wide range of variability in many Ophryoscolecidae (genus Entodinium Diplodinium), and, in some instances, to establish connection between some changes and the environmental conditions.

It is necessary to mention specially the work carried out by G.GAUSE and his collaborators N.SMARAGDOVA and C. MASTJUKOVA (1933-1941) on natural selection in Protozoa and the mechanism and geographical variability. In the experimentally obtained microcosmoses containing different, in respect to their ecology, forms (Paramecium is bacteriophagous, Bursaria and Didinium are carnivorous). GAUSE and his collaborators managed to establish some quantitative regularity in fluctuations of the number of microcosmic components connected with the dynamics of selection and struggle for existence. The mechanism in the populations which leads to adaptations to unfavourable environments has been studied.

As it has been mentioned above, in the USSR, alongside with theoretical studies on Protozoam there have been carried out

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investigations in veterinary and medical protozoology (studies of G.EPSTEIN, A.PHILIPSCHENKO and V. ONEZDILOV on parasitic Protozoa of the human intestins, those of YAKIMOFF and his numerous collaborators on trypanosomes, coccidia, piroplasmoses; A. MARKOV 's on piroplasmoses; N.LATISHEV's on leishmanosis; MARZIENOWSKY's and Sh. MOSHKOWSKI's on malaria; D.SASSUCHIN's on toxoplasmosis; A. TZELISHEV's on Theileriosis etc.). However, a detailed analysis of these investigations is far beyond the limits of the present account.

Protozoological investigations, so successfully carried out during the previous years, are being developped nowadays on a larger scale. Below we shall point out briefly the principal branches of prototoological investigations which are being carried out in the USSR.

In the field of systematics and faunistics marine forms of free-living Protozoa, namely, Foraminifera and Radiolalia are being studied. A number of protozoologists are working on the systematics of many groups of parasitic Protozoa, such as trypanosomes, coccidia, gregarines, piroplasmides, myxosporidia. Numerous studies on life cycles of different groups of Protozoa are being made, most of them are characterized with cytological and cytochemical approach. A further elaboration of the problems concerning the nature and origin of the nuclear dualism and polyploidy of Protozoa are being carried.

The investigations of physiologists of Protozoa are centred around the problems of adaptations and the phenomena of irritability and physiological gradient.

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The specialists in genetics of Protozoa have initiated studying syngenes of different species of Paramecium and geographical variability of Infusoria.

Recently Soviet investigators have begun electron-microscopic investigation of different groups of Protozoa. They are studying submicroscopic changes of cellular structures under different conditions of ciliates. Besides, our scientifists are working on submicroscopic structures of some groups of Sporozoa - Coccidia and Myxosporidia.

Protozoa are used as objects for studying effects of various forms of penetrating radiation on the cell.

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